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### Abstract

A key issue for remote Australian desert community viability is providing services such as health and education, particularly given the limited telecommunications infrastructure. To help address this issue, we examine how satellite Digital Video Broadcast (DVB) TV can support new telecommunications services for these communities. In particular, we consider options for the DVB based multicast which underpins these services. We show that existing DVB and MHP capabilities can provide the required multicast support.

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# Satellite DVB Multicast for Remote Desert Community Messaging

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**Abstract – A key issue for remote Australian desert community viability is providing services such as health and education, particularly given the limited telecommunications infrastructure. To help address this issue, we examine how satellite Digital Video Broadcast (DVB) TV can support new telecommunications services for these communities. In particular, we consider options for the DVB based multicast which underpins these services. We show that existing DVB and MHP capabilities can provide the required multicast support.**

## I. INTRODUCTION.

This paper investigates using data transmission capabilities of Satellite TV to underpin new communications services for remote desert communities. In particular, the use of IP and related protocols over satellite DVB paths will be considered, along with means for incorporating the resulting data transmission into existing TV programs. Efficient merging of IP and DVB protocols is an active research area within the Internet Engineering Task Force (IETF) [1]. This paper will summarise the IETF work and satellite multicast issues, show where they relate to this current project, and outline where new developments are needed.

Australian remote desert communities receive television in three ways. The first is Direct to Home (DTH), sent over the Optus Aurora platform and received via individual satellite dishes and Set Top Boxes (STBs). This provides channels such as Imparja (the key Australian Indigenous Broadcaster), ABC, SBS, Central 7 and WIN. DTH is used in very small communities, e.g. four houses or less, and outstations. The second method is community re-broadcast, used in larger communities. Here satellite TV programs are received, then re-broadcast over analog channels. Community re-broadcast viewers use analog receivers, and hence cannot access interactive content. The third method is satellite pay TV, which provides Foxtel programming, but not Imparja. In this paper we focus on DTH and community re-broadcast.

The Desert Knowledge Cooperative Research Centre (DK-CRC) is a wide ranging research effort, aimed at improving the viability of remote Australian desert communities. The Desert Interactive Remote Television (DIRT) project, within the DK-CRC, is a collaboration between the University of Wollongong and Murdoch University. Murdoch University provides design and

evaluation of remote community iTV services for the project, while the University of Wollongong considers the technical issues related to delivering these services. These technical issues are the focus of this paper.

The proposed DIRT communications services fall into two categories. The first is messaging to individual TVs, or more commonly, to the TVs within specific communities. Example message types could be emergency warnings, community events, and service agency visits. The current DTH system has a limited messaging capability, where short text messages can be sent to individual receivers. However, given poor literacy in many remote Desert communities, audio based messaging systems are likely to be more effective. The second proposed communication service category is longer video/audio programs, for example training material. This service will build on the storage capabilities of emerging PVRs, so that a given package may be sent once, but viewed many times.

The DIRT project will build on three emerging technical capabilities. The first is incorporating IP data transmissions with satellite TV broadcasts. While IP traffic is commonly sent over satellite paths, e.g. for broadband service provision, this is done separately to the satellite TV broadcast. The second capability is the Multimedia Home Platform (MHP). This provides a powerful open source programming environment, which, similar to JAVA, allows a given application to be run on a wide range of STBs. The third capability is data storage capability of Personal Video Recorders (PVR), which would allow DIRT applications to be viewed on demand.

A key requirement underpinning these capabilities is the ability to direct data broadcast to groups of STBs. This multicast transmission is different from standard IP multicast, as there is no return path. Hence standard multicast protocols (e.g. IGMP) cannot be used, nor can address resolution and configuration protocols, such as ARP and DHCP respectively. These issues are currently being considered by the IETF IP over DVB working group.

This paper will review current remote TV infrastructure, and potential DIRT project applications arising from it in section II. Current work on satellite multicast will then be outlined in section III, as well as IP over DVB working group activities relevant to the DIRT project. Section IV will consider the IP configuration and address resolution mechanisms in satellite DVB environments, along with a

proposed address resolution scheme also be outlined. Section V concludes the paper.

## II. CURRENT INFRASTRUCTURE AND POTENTIAL APPLICATIONS

Figure 1 shows the DTH and community re-broadcast configurations. DTH viewers interact directly with the STB, and hence can respond to ITV programming. Community re-broadcast viewers watch analog channels, and hence cannot access digital content. However, community re-broadcast potentially allows cost effective use of custom equipment, e.g. receivers configured for specific DIRT project applications, as a single installation will cover a whole community. Based on these infrastructures, potential applications are outlined below.

### DTH

As DTH viewers interact directly with digital content, a wide range of applications are available. Low rate applications, e.g. with images and short voice messages, may be accessed via a DVB data carousel, as described in a previous DIRT project paper [2]. These messages may be saved (assuming STB storage capability) and viewed on demand, otherwise viewers wait for the carousel to repeat messages, and watch them in real time.

High data rate applications, e.g. with long video sequences, will require a different approach for DTH clients. Examples of these applications could be interactive training packages, comprising a series of video/audio segments navigated via an ITV interface. Given the likely satellite capacity available for these application (e.g. 1 Mbps or less [2]), they would not be viewed in real time, but instead stored on client PVRs, and viewed on demand. A key DIRT project task will be to design the MHP applications to manage this PVR storage and interactive playback. Another issue is power, as many communities rely on generators, which only operate for a few hours per day. The DIRT project will investigate mechanisms which allow client PVRs to remain on, to order record these targeted broadcasts.

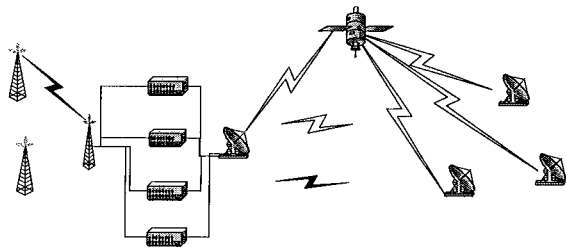


Figure 1: DTH and Community Re-broadcast Infrastructures

### Community Re-Broadcast

This infrastructure is considered cost effective for communities of around 5 households or more. As shown in figure 1, a separate receiver/modulator is used for each channel, with 4 analog UHF channels generally available.

PY Media has installed equipment in some sites, which allows remote switching between ABC and Channel 31.

The community re-broadcast clearly does not allow individual users to interact with digital content, and hence potential DIRT applications are more limited. However, given that a single site services a whole community, the installation of custom infrastructure may be cost effective (as mentioned). Also, community re-broadcast sites may potentially link with the broadband Internet facilities (fibre or satellite) available in larger communities. These two possibilities, custom infrastructure and broadband access, enable some interesting applications, as follows:

1) A key DIRT project aim is to allow low cost TV based community messaging. A system known as Go-Dot, developed at Murdoch University, signals these messages with a dot in a corner of the screen. Users then access the messages via specific handset buttons, returning to normal viewing once the messages have been read. In a community re-broadcast situation, the Go Dot messages would need to be transmitted on a separate analog TV channel. Prior to this, the messages could be sent via broadband Internet, rather than the satellite TV DVB stream. This messaging system would need the following infrastructure at the re-broadcast site

- a UHF modulator/transmitter for the additional messaging TV channel
- a device to receive messages over an Ethernet interface (i.e. via the Internet) store them, then play them out over the message channel. A prototype of a device with these capabilities is being built at the University of Wollongong
- A link between the community Internet hub and the re-broadcast infrastructure. An 802.11 wireless link would be a cost effective choice for this, if these two facilities are not co-located.

2) Advertisements are the key messaging tool for commercial TV. However, normal TV advertising costs are far beyond the reach of most communities. A solution could be a commercial operator (e.g. Imparja) providing regular ad breaks, (e.g. a block of four 30 second spots every hour), filled with messages aimed at specific communities. Hence during these breaks, a wide variety of different ads/messages would be playing across the remote communities within the Imparja footprint. Imparja could offer these blocks at heavily discounted rates, while still turning a profit on the aggregate return. A default ad (e.g. Imparja promotion) could be sent during these blocks, and viewed by communities who do not have messages/ads of their own

This application would require the messages/ads to be sent ahead of time, stored, then broadcast over the Imparja analog community channel at the programmed time. Again, these messages could be sent via the community broadband Internet, rather than the satellite TV interface. Infrastructure needed for this ad based messaging would be as follows

- a device to receive messages over an Ethernet interface (i.e. via the Internet) store them, then play them at the scheduled times. As mentioned, a prototype of this device is being built at the University of Wollongong.
- A link between the community Internet hub and the re-broadcast infrastructure.
- A means to synchronise the message payout with the Imparja ad breaks. This could be done using a pre-arranged timetable, sent via the Internet interface, or by prompts sent in a separate logical channel within the Imparja program.
- A secure Web based interface for downloading messages. This centralised Web based location would form a key part of the Go-Dot infrastructure planned for the DIRT project, and is being developed at Murdoch University.

The community re-broadcast messaging schemes outlined above do not require significant changes to the satellite TV broadcast, as additional broadcast material (i.e. messages) are sent via the Internet. However a custom device is needed, which can interleave broadcast TV with program material received over the Internet.

Community re-broadcast is currently used by most remote community residents, with DTH penetration at around 10%. However, with increasing penetration of digital TV, all viewers will eventually receive digital signals, and hence interact directly with ITV content, such as the Go Dot applications planned within the DIRT project. Hence the DTH applications considered here will eventually be available to all viewers.

We now consider technical details associated with transmitting additional DTH content via satellite TV infrastructure, beginning with satellite multicast issues, then mechanisms for IP transmissions over the uni-directional paths associated with remote community DTH installations.

### III SATELLITE MULTICASTING

The traditional Internet data delivery model, comprising a single source and receiver, is known as unicast. For more than a decade, intense research effort has been directed to multicast, where a single source (or multiple sources) transmit to multiple receivers. The DIRT project applications involve satellite multicast, as follows:

- DTH applications multicast data to STBs (e.g. within a group of communities comprising a single language group), using satellite DVB TV transmission, without a return path
- The community re-broadcast applications outlined above multicast data to STBs, via satellite broadband

We outline the key (satellite) multicast issues and protocol developments, then describe how they relate to the DIRT project.

While multicast protocols allow multiple sources to transmit to multiple receivers, we consider the single source, multiple receiver case (which applies to DIRT project applications). There are three key protocol requirements for multicast: a method for joining/leaving multicast groups, routing protocols to move data to the correct destinations (i.e. the multicast receivers), and mechanisms for ensuring reliable data transfer. We consider each requirement in turn.

A multicast group comprises the source(s) and multiple receivers. In particular, a receiver should be able to join/leave a multicast group without the source needing to be involved in the changes. The IETF has specified the Internet Group Multicast Protocol (IGMP) [3] to allow dynamic multicast group changes. To join a multicast group, a source sends an IGMP Membership Report message to its adjacent router, indicating the multicast address of the desired group. To track memberships changes, routers periodically send IGMP Membership Query messages to adjacent interfaces (i.e. receivers), which then respond with their current status. No response means that a receiver has left the multicast group, and hence the router stops forwarding multicast packets. A key purpose of IGMP is to establish the required router table entries, so that multicast data can be forwarded to all receivers within the group.

The main idea of multicast is to forward data only to the receivers within the group, rather than to all receivers within the Internet (clearly an unworkable proposition). Hence routing protocols are needed, so that routers between multicast sources and receivers can direct incoming packets to their respective destinations. Two types of multicast routing protocols have emerged. The first type, known as reverse path broadcast, has sources transmitting data to all adjacent routers, which then drop traffic with addresses not belonging to known groups. This scheme, implemented in protocols such as Protocol Independent Multicast - Dense Mode [4], works well if multicast receivers are closely spaced (e.g. within the same city). For widely spaced receivers (e.g. in different countries), another class of multicast routing protocols have emerged, based on specific routers being designated as "Rendezvous Points" (RP). Multicast traffic initially flows through these routers, after which receivers establish specific paths to multicast sources. The key example of this method is Protocol Independent Multicast - Sparse Mode [5].

Reliable data transfer is usually achieved by sources resending data packets which have not been correctly received. This technique, known as Automatic Repeat Request (ARQ), requires receivers to inform the source of the correct arrival (or otherwise) of data packets. ARQ protocols for unicast are widely used and well understood (the one most commonly used is part of TCP). However multicast ARQ protocols, generally known as "reliable multicast", face a more challenging task, as correct data delivery must be ensured for all receivers in the group. In

particular, for large multicast groups, acknowledgements of packet arrivals from all receivers would overwhelm the source. To avoid this problem, reliable multicast protocols aggregate packet arrival acknowledgements from multiple receivers within multicast groups. These aggregated acknowledgements are then forwarded to the source.

The DIRT project DTH infrastructure, i.e. satellite DVB forward path to an STB, with no return path is a special case of multicast. In particular, all multicast receivers (i.e. STBs) are a single hop over from the source (this hop being the satellite link). This contrasts with multicast in the fixed (terrestrial) Internet, where data for individual receivers traverses multiple hops (routers). The most common satellite multicast scenario is where receivers have a fixed Internet connection (e.g. dialup) back to the source. This provides a return path (not available with the STBs in remote communities considered in the DIRT project), but also creates an interesting problem, as there are two potential forward paths, one over the satellite link, the other over the fixed Internet between the source and receiver. Clearly the satellite path is the most efficient means for sending multicast data, hence a technique is needed for using the fixed return path, while ignoring the alternate fixed forward path. The protocol mechanisms for this are outlined in RFC 3077 [6], which describes a method for encapsulating return path packets and transferring them over the bi-directional terrestrial links (this method is called Link-Layer Tunnelling Mechanism for Unidirectional Links (LLTM)).

While the LLTM mechanism clearly will not work in DTH installations (which lack a return path), it may be suitable for the community re-broadcast multicast scenario, where content is via two way satellite broadband, rather than the satellite TV broadcast. However, two problems have been identified for LLTM satellite multicast. The first arises from PIM-SM routing, where sending join/prune messages via the LLTM fixed return link will automatically cause multicast traffic to use the fixed forward link, rather than the desired satellite one. A suggested solution to this is to configure all receivers to use a router located at the source as the RP [7]. Then multicast traffic will use the satellite link, as it will be the shortest path to the receivers. The second problem arises from reliable multicast, based on negative acknowledgements (NACKs) sent by multicast receivers. In the LLTM scenario, where the source is essentially a single hop from the receivers (via the LLTM tunnel), NACKs will arrive almost simultaneously. To avoid the load arising from this, a method for staggered NACK generation is proposed in [8].

The DTH multicast scenario differs from the community re-broadcast one, as DTH has no return path. Reliable multicast for receivers without return paths is based on Forward Error Correction (FEC), with typical applications being software updates for large receiver populations. In these cases, a data carousel broadcasts the data continuously for a given period (e.g. a day), after which

all receivers are assumed to have correctly received it. A framework for this one way reliable multicast is outlined in [9] while details of FEC techniques are described in [10].

Hence for the DIRT project DTH multicast (without return paths), this FEC based data carousel approach, where specific content remains in the carousel until all receivers are assumed to have accessed it, appears the most feasible. A key issue however is bandwidth cost. The annual cost of 1 Mbps of satellite bandwidth is around \$300k. Based on this, the daily cost of 100 kbps of satellite bandwidth is around \$80. If we consider a 10 Mbyte content block, and add 50% overhead for FEC and other protocol overheads, then 100 kbps will deliver this in around 20 minutes (with 33 kbps delivering the content in an hour). If we assume the lower rate, and also assume that the content needs to remain in the carousel for 5 days, to ensure that all receivers have picked it up, then the bandwidth cost to deliver this content is around \$130. Clearly the issue with this distribution method is for the DTH STBs to be on while the content is being sent. For communities relying on generator power, this “on” period may only be a few hours per day. An alternative may be to provide battery backup for STBs, ensuring that they are always on. In this case, a much short content transmission period would be needed, thereby lowering bandwidth costs, and increasing system capacity.

The multicast scenarios considered here assume that undying IP mechanisms, e.g. address configuration and resolution, are operating. However, as mentioned, efficient IP transport over DVB is a current research area. We now outline the key IP over DVB issues, and relate them to the DIRT project applications.

#### IV. DVB TRANSMISSION AND ADDRESSING MECHANISMS

The IP over DVB working group “will develop new protocols and architectures to enable better deployment of IP over MPEG-2 transport and provide easier interworking with IP networks”. Two key items have emerged from the IP over DVB work, a new method for encapsulating IP datagrams within DVB transmissions, and address resolution. We consider these items in turn.

Current DVB standards support IP (and other) protocols by means of “Multi Protocol Encapsulation” (MPE). This uses private sections within the Digital Storage Media – Command and Control (DSM-CC) framework [9]. DSM-CC provides a client server based scheme for broadband multimedia service delivery, which in particular supports data carousels. MPE identifies receivers via a 48 bit MAC address, with a LLC-SNAP header used to support a range of protocol payloads (e.g. IP).

IP over DVB has defined an alternate encapsulation scheme, known as Ultra Lightweight Encapsulation (ULE) [12], which addresses MPE shortcomings. Encapsulated packets are known as Subnetwork Data Units (SNDU).

ULE allows multiple SNDUs to occupy a single MPEG-2 packet (unlike MPE). Other key ULE features are CRC error checking, protocol identification (i.e. indication of SNDU contents), and SNDU length indication.

While the ULE scheme will provide a more efficient means for IP packet transport over DVB, the key IP over DVB work of interest to the DIRT project is address resolution. Imparja STBs are currently identified by Conditional Access (CA) IDs, which allow short text messages to be sent to specific STBs. Also, these IDs allow given TV programs to be restricted to specific groups of viewers. However, this CA based addressing scheme does not support substantial data transfers (e.g. video/audio content), nor does it allow the multicast addressing capability needed for DIRT project applications. In particular, IP based DIRT project applications will require the following capabilities:

- associating unicast/multicast addresses with specific DVB multiplexes and Transport Stream (TS) Logical Channels
- assignment of unicast IP addresses to STBs. This may be either static (i.e. pre-configured) or dynamic
- dynamic binding of multicast IP addresses to groups of unicast IP addresses (e.g. belonging to the STBs within a given community)

We examine these capabilities in turn.

There is usually an implicit association between an IP data flow and the physical media which carries it, e.g. an Ethernet interface. However, with satellite DVB, this association is not clear, as a given receiver may have a choice of multiplexes. Each multiplex may have one or more IP flows, carried within a specific Transport Stream (TS) Logical Channels (identified by PIDs). Hence a mechanism is needed to link specific IP (or MAC) addresses to their respective multiplexes and TS Logical Channel PIDs. This may be done in two ways:

-The DVB standards have recently been extended to include a table, known as the IP/MAC Notification Table (INT), which link addresses to specific multiplexes and Transport Streams [13]. The INT applies the MPE sections only (i.e. not ULE, which has yet to be standardised), and applies to a wide range of address types, e.g. MAC, IP v4, IPv6, Smartcard etc. Hence, using the INT, which is contained in a well known PID, a receiver can locate the data stream associated with its own address.

-The MHP Application Information Table (AIT) provides a means for mapping IP addresses to DVB component tags [13]

Of these two methods, the DVB INT table appears the more flexible.

In order for an STB to be part of an IP network, an IP address must be assigned to it. This may be done

statically (i.e. be pre-configured), through a proprietary interface. In most IP networks however, the DHCP protocol is used to automatically assign IP addresses. However, the remote community STBs considered in the DIRT project cannot use DHCP, as it relies on a return path. IP address configuration is a current research area in the IP over DVB working group [14]. Given that the Imparja STBs are most commonly identified by Smartcard IDs, these could be used for IP address configuration. Here the DVB INT table could be used, with Smartcard IDs as the Target Descriptor, and their associated IP addresses as part of the Operational Descriptor.

If we assume that the DIRT applications are the only IP data in the Imparja broadcast, then a private IP addressing scheme may be used. This will allow assigned IP addresses to be organised hierarchically, on the basis of geographical or cultural linkages between community STB groups.

Once an IP address has been assigned to an STB, and binding established between the address and its associated multiplex and Transport Stream, then a method for assigning specific receivers to multicast groups is needed. For standard IP networks, i.e. with return paths, this joining of multicast groups is receiver driven, using IGMP as indicated earlier. However, for the STBs (i.e. multicast receivers) considered in the DIRT project, the lack of return path means that receivers are unable to choose which multicast groups they will join. Hence, assigning receivers to their respective multicast groups must be done by the source (i.e. at the satellite head end). Currently there are no standardised protocols to do this. We propose the following table based method.

-All receivers monitor the "All Systems" multicast address (224.0.0.1). This broadcasts to all hosts (receivers) on a subnet, which in this case comprises the subnet which includes all DIRT project STBs.

-A table containing the mappings between each unicast address and its associated multicast address(es) is transmitted continuously over the All Systems multicast address.

Hence by monitoring this table, a given STB can learn the multicast addresses which it should be listening to. This provides an efficient means for dynamically changing multicast group membership, e.g. determining which set of communities receive a given message, associated with a specific multicast address.

## VI. CONCLUSIONS

This paper has considered remote desert community communications services, based on satellite TV. Direct to Home (DTH) and community re-broadcast infrastructures have been described, along with potential applications. Key technical considerations for satellite multicast have been outlined, i.e. group membership, routing, and reliability. In particular, FEC based mechanisms have

been identified for DTH applications, without return paths. Finally, current developments for IP over DVB have been reviewed, and proposals outlined for IP configurations and dynamic multicast group management for DIRT project infrastructure.

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## VII. REFERENCES

- [1] IP over DVB Working Group, Internet Engineering Task Force, [www.ietf.org](http://www.ietf.org)
- [2] T. Eyers, Messaging for Remote Australian Desert Communities using Satellite DVB Multicast, ATNAC, Sydney, December, 2004
- [3] B. Cain et al, Internet Group Management Protocol, Version 3, RFC 3376, October, 2002
- [4] A. Adams et al, Protocol Independent Multicast - Dense Mode (PIM-DM): Protocol Specification (Revised), RFC 3973, January, 2005
- [5] D. Estrin et al, Protocol Independent Multicast-Sparse Mode (PIM-SM): Protocol Specification, RFC 2362, June, 1998
- [6] E. Duros et al, "A Link-Layer Tunneling Mechanism for Unidirectional Links", RFC 3077, March, 2001
- [7] A. Thamrin et al, "PIM-SM Configuration and Scalability on Satellite Unidirectional Links", Symposium on Applications and the Internet Workshops, January, 2003
- [8] M. Nishida et al, "The Design and Implementation of Data Dissemination Application Using Multicast over a Satellite Network", Symposium on Applications and the Internet Workshops, January, 2003
- [9] M. Luby et al, "Asynchronous Layered Coding (ALC) Protocol Instantiation", RFC 3450, December, 2002
- [10] M. Luby et al, "The Use of Forward Error Correction (FEC) in Reliable Multicast", RFC 3453, December, 2002
- [11] ISO/IEC 13818-6: "Information technology -- Generic coding of moving pictures and associated audio information -- Part 6: Extensions for DSM-CC"
- [12] G. Fairhurst et al, "Ultra Lightweight Encapsulation (ULE) for transmission of IP datagrams over an MPEG-2 Transport Stream", Internet Draft, February, 2005
- [13] ETSI EN 301 192 V1.4.1, "Digital Video Broadcasting (DVB); DVB specification for data broadcasting", 2004
- [13] G. Fairhurst et al, "Address Resolution for IP datagrams over MPEG-2 networks", Internet Draft, February, 2005
- [14] M. Stiernerling, "Problem Statement: IP Address Configuration for IPDVB", Internet draft, February, 2005